

02-12-01

09/762652 T

JC06 Rec'd PCT/PTO 09 FEB 2001

PATENT



Practitioner's Docket No. 6114

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. § 601, 7th ed.

**TRANSMITTAL LETTER TO THE U.S. DESIGNATED OFFICE (DO/US)—  
ENTRY INTO THE U.S. NATIONAL STAGE UNDER CHAPTER I**

PCT/GB00/02266	12 June 2000	11 June 1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
IMPROVEMENTS IN ROLLING ELEMENTS BEARINGS		
TITLE OF INVENTION		
DODD, Andrew; DICKS, Mark Philip; TAYLOR, Mark Stephen		
APPLICANT(S)		

**Box PCT**  
**Assistant Commissioner for Patents**  
**Washington D.C. 20231**

**ATTENTION: DO/US**

NOTE: The completion of those filing requirements that can be made at a time later than 20 months from the priority date results from the Commissioner exercising his judgment under the authority granted under 35 U.S.C. § 371(d). The filing receipt will show the actual date of receipt of the last item completing the entry into the national phase. See 37 C.F.R. § 1.491, which states: "An international application enters the national stage when the applicant has filed the documents and fees required by 35 USC 371(c) within the periods set forth in § 1.494 and § 1.495."

**CERTIFICATION UNDER 37 C.F.R. § 1.10\***

(Express Mail label number is mandatory.)  
(Express Mail certification is optional.)

I hereby certify that this Transmittal Letter and the papers indicated as being transmitted therewith is being deposited with the United States Postal Service on this date 9 February 2001, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL733959222US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Sarah Kennedy

(type or print name of person mailing paper)

Signature of person mailing paper

(Transmittal Letter to the United States Designated Office (DO/US)—Entry into National Stage under  
35 U.S.C. § 371 [13-6]—page 1 of 8)

09/762652

**WARNING:** Where the items are those that can be submitted to complete the entry of the international application into the national phase subsequent to 20 months from the priority date, the application is still considered to be in the international stage. And if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. § 1.10 must be used (because international application papers are not covered by an ordinary certificate of mailing. 37 C.F.R. § 1.8(2)(xi)).

**WARNING:** Documents and fees must be clearly identified as a submission to enter the national stage under 35 U.S.C. § 371, otherwise the submission will be considered as being made under 35 U.S.C. § 111. 37 C.F.R. § 1.494(f).

**WARNING:** Failure to pay the national fee within 20 months from the priority date will result in the abandonment of the application. The time for payment of the basic fee is not extendable. M.P.E.P. § 1893.01(a)(1), 6th ed., rev. 3.

1. Applicant herewith submits to the United States Designated Office (DO/US) the following items under 35 U.S.C. § 371:

- a. ☒ This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).
- b. ☒ The U.S. National Fee (35 U.S.C. § 371(c)(1)) and
- ☐ other fees (37 C.F.R. § 1.492), as indicated below:

## 2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
<input type="checkbox"/> *	TOTAL CLAIMS	10 —20=		×\$ 18.00=	\$ 0.00
	INDEPENDENT CLAIMS	2 —3=		×\$ 80.00=	0.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00				
BASIC FEE**	The international search fee, as set forth in § 1.445(a)(2) to be paid to the US PTO acting as an International Searching Authority: <input type="checkbox"/> has been paid (37 CFR 1.492(a)(2)) ..... \$710.00 <input type="checkbox"/> has not been paid (37 CFR 1.492(a)(3)) ..... \$1000.00 <input checked="" type="checkbox"/> where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) ..... \$860.00				860.00
	Total of above Calculations				=860.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed also. (note 37 CFR 1.9, 1.27, 1.28)				—
	Subtotal				860.00
	Total National Fee				\$ 860.00
	Fee for recording the enclosed assignment document \$40.00 (37 CFR 1.21(h)). (See Item 10 below). See attached "ASSIGNMENT COVER SHEET (37 C.F.R. § 3.34)".				
TOTAL	Total Fees enclosed				\$ 860.00

\*See attached Preliminary Amendment Reducing the Number of Claims.

\*\*WARNING: "To avoid abandonment of the application, the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 20 months from the priority date: \* \* \* (2) the basic national fee (see § 1.492(a)). The 20-month time limit may not be extended." 37 C.F.R. § 1.494(b).

(Transmittal Letter to the United States Designated Office (DO/US)—Entry into National Stage under 35 U.S.C. § 371 [13-6]—page 3 of 8)

09/762652-040

- ☐ Attached is a ☒ check ☐ money order in the amount of \$ 860.00
- ☒ Authorization is hereby made to charge the amount of \$ \_\_\_\_\_
- ☒ to Deposit Account No. 19-0079
- ☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

**WARNING:** Credit card information should **not** be included on this form as it may become public.

- ☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

**WARNING:** If the translations of the international application and/or the oath or declaration have not been submitted by the applicant within twenty (20) months from the priority date, the applicant will be so notified and given a period of time within which to file the translation and/or oath or declaration in order to prevent abandonment. The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than twenty (20) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than twenty (20) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 will apply. 37 C.F.R. § 1.494(c).

3. A copy of the International application as filed (35 U.S.C. § 371(c)(2)):
- ☒ is transmitted herewith.
  - ☐ is not required, as the application was filed with the United States Receiving Office.
  - ☒ has been transmitted
    - ☒ by the International Bureau. Date of mailing of the application (from form PCT/IB/308): 21 December 2000
    - ☐ by applicant on \_\_\_\_\_. (Date)

**NOTE:** Section 1.494(b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 20 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies the applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage and applicant has received notice from the International Bureau, applicant need only pay the basic national fee by 20 months from the priority date." [This can now be paid subsequently with a surcharge.] Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35.

4. ☒ A translation of the International application into the English language (35 U.S.C. § 371(c)(2)):
- ☐ is transmitted herewith.
  - ☒ is not required as the application was filed in English.
  - ☐ was previously transmitted by applicant on \_\_\_\_\_. (Date)

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)):

NOTE: The Notice of January 7, 1993 indicates that 37 C.F.R. § 1.494(d) was "amended to clarify the existing practice that PCT Article 19 Amendments must be submitted by 20 months from the priority date, which time may not be extended." This Notice further advises: "Of course, the failure to do so does not result in loss of the subject matter of PCT Article 19 amendments. The applicant may submit that subject matter in a preliminary amendment filed under Section 1.121. In many cases, filing an amendment under Section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 35. See item 11(c) below. See also 37 C.F.R. § 1.494(d).

- a. ☐ are transmitted herewith.
  - b. ☒ have been transmitted
    - i. ☒ by the International Bureau. Date of mailing of the amendment (from form PCT/IB/308): 21 December 2000
    - ii. ☐ by applicant on \_\_\_\_\_ (Date)
  - c. ☐ have not been transmitted, as
    - i. ☐ no notification has been received that the International Search Authority has received the Search Copy.
    - ii. ☐ the Search Copy was received by the International Searching Authority, but the Search Report has not yet been issued. Date of receipt of Search Copy (from form PCT/ISA/202): \_\_\_\_\_
    - iii. ☐ applicant chose not to make amendments under PCT Article 19. Date of mailing of Search Report (from form PCT/ISA/210): \_\_\_\_\_
    - iv. ☐ the time limit for the submission of amendments has not yet expired. The amendments, or a statement that amendments have not been made, will be transmitted before the expiration of the time limit under PCT Rule 46.1.
6. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. § 371(c)(3)):
- a. ☐ is transmitted herewith.
  - b. ☒ is not required as the amendments were made in the English language.
  - c. ☐ has not been transmitted for reasons indicated at point 5(c) above.
7. ☒ An oath or declaration of the inventor, including power of attorney, (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115
- a. ☐ was previously submitted by applicant on \_\_\_\_\_ (Date)
  - b. ☐ is submitted herewith, and such oath or declaration
    - i. ☐ is attached to the application.
    - ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or (c) and 5(b); and states that they were reviewed by the inventor, as required by 37 C.F.R. § 1.70.
    - iii. ☒ will follow.

**Other document(s) or information included:**

8. ☒ An international Search Report or Declaration under PCT Article 17(2)(a):
- ☒ is transmitted herewith.
  - ☐ has been transmitted by the International Bureau. Date of mailing (from form PCT/IB/308): \_\_\_\_\_
  - ☐ is not required, as the application was searched by the United States International Searching Authority.
  - ☐ will be transmitted promptly upon request.
  - ☐ has been submitted by applicant on \_\_\_\_\_ (Date)
  - ☐ is not transmitted, as the international search has not yet issued.
9. ☒ An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98:
- ☐ is transmitted herewith.  
Also transmitted herewith is (are)  
☐ Form PTO—1449 (PTO/SB/08A and 08B)  
☐ Copies of citations listed
  - ☒ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. § 371(c).
  - ☐ was previously submitted by applicant on \_\_\_\_\_ (Date)
10. ☐ An assignment document is transmitted herewith for recording. A separate  
☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or  
☐ FORM PTO—1595  
is also attached.  
☐ Please mail the recorded assignment document to:
- ☐ the person whose signature and address appears below.
  - ☐ the following:

- NOTE: Petition to revive (37 C.F.R. § 1.137(a) or (b)) is necessary if 35 U.S.C. § 371 requirements are submitted after 20 months.

**WARNING:** Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.

**NOTE:** "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

- ☒ 37 C.F.R. § 1.492(a)(1), (2), (3), and (4) (filing fees)

☒ 37 C.F.R. § 1.492(b), (c), and (d) (presentation of extra claims)

☒ 37 C.F.R. § 1.17 (application processing fees)

- (Transmittal Letter to the United States Designated Office (DO/US)—Entry into National Stage under 35 U.S.C. § 371 [13-6]—page 7 of 8)

- ☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b)).

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying or at the time of paying . . . issue fee. . . ." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

- ☐ 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 20 months after the priority date.

  
 Signature of practitioner

Reg. No. 35,985

Arlene J. Powers  
 (type or print name of practitioner)

Tel. No.: ( 617 ) 426-9180  
 ext. 110

Samuels, Gauthier & Stevens LLP  
 225 Franklin Street, Suite 3300  
 P.O. Address

Customer No.:

Boston, Massachusetts 02110



09/762652

JC02 Rec'd PCT/PTO 09 FEB 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: Andrew Dodd et al. GROUP: Unknown  
SERIAL NO: Unknown EXAMINER: Unknown  
FILED: Herewith  
FOR: IMPROVEMENTS IN ROLLING ELEMENTS BEARINGS

Assistant Commissioner of Patents  
Washington, D.C. 20231  
Sir:

PRELIMINARY AMENDMENT

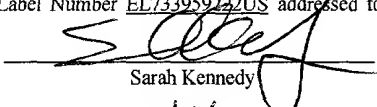
Preliminary to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend the claims as follows:

1. (Amended) [A method of treatment of] Use of non-corrosive hard particle abrasion to  
treat a rolling element bearing component, [by hard particle abrasion of the component] the hard  
particle abrasion including the steps of:  
immersing the bearing component in a receptacle containing hard particles; and  
agitating the bearing component and/or hard particles to produce relative movement  
therebetween and to improve the surface topography of the component.

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited on in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL733959222US addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

  
Sarah Kennedy

Date 2/9/01

2. (Amended) [A method] Use according to claim 1, wherein the [method] hard particle abrasion is performed for between 10 minutes and 1 hour.

3. (Amended) [A method] Use according to claim 1 [or 2], wherein the relative movement is produced by rotating the component in one direction while the receptacle is rotated in the opposite direction.

4. (Amended) [A method] Use according to [any one of claims 1 to 3] claim 1, [whereby the surface finish of the component is improved from around 0.13  $\mu\text{m}$  to around 0.07  $\mu\text{m}$ ] wherein the hard particles comprise alumina.

Please cancel claims 5-10.

Please include the following new claims:

11. A rolling element bearing component treated in accordance with [any one of the preceding claims] claim 1.

12. A rolling element bearing component according to claim 11, wherein the surface finish of the component is improved from around 0.13  $\mu\text{m}$  to around 0.07  $\mu\text{m}$ .

13. A rolling element bearing component according to claim 11[ or 12], wherein the compressive stress in the surface of the component is increased by between 200 MPa and 500 MPa.

14. A rolling element bearing component according to [any one of claims 11 to 13] claim 11, wherein the rolling contact fatigue life of the component is significantly enhanced.

1 15. A rolling element bearing component according to [any of claims 11-14] claim 11,  
2 wherein a surface finish component is produced which requires no further machining.

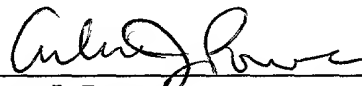
1 16. A rolling element bearing comprising one or more components according to [any one  
2 of claims 11-15] claim 11.

### REMARKS

The present preliminary amendment is submitted in order to correct minor deficiencies  
noted in the PCT application and to conform the application with U.S. practice.

Examination on the merits is respectfully requested.

Respectfully submitted,



Arlene J. Powers

Registration No. 35,985

Samuels, Gauthier & Stevens

225 Franklin Street, Suite 3300

Boston, Massachusetts 02110

Telephone: (617) 426-9180

Extension 110

**IMPROVEMENTS IN ROLLING ELEMENTS BEARINGS****TECHNICAL FIELD**

The present invention relates to rolling element bearings and, more particularly, the invention relates to improvements in the performance of such bearings by treatment of the individual bearing components subjected to rolling contact during use i.e. the inner ring, outer ring and rolling elements.

**SUMMARY OF THE INVENTION**

It is an object of the invention to provide a method of treatment of such rolling element bearing components to improve the properties of the component. It is also an object of the present invention to improve the performance of bearings generally.

According to an aspect of the invention there is provided a method of treatment of a rolling element bearing component by hard particle abrasion of the component, the hard particle abrasion comprising the steps of:

immersing the bearing component in a receptacle containing hard particles; and  
agitating the bearing component and/or hard particles to produce relative movement therebetween and to improve the surface topography of the component.

09762652-042701

According to another aspect of the invention there is provided a rolling element bearing component treated in accordance with the method of the invention.

According to a further aspect of the invention there is provided a rolling element bearing comprising such a component or components.

## BACKGROUND

The process of hard particle abrasion, or ceramic abrasion, is known in the art and hard particle abrasion equipment is commercially available.

## DESCRIPTION

Hard particle abrasion of rolling element bearing components may simply involve immersing one or more of the bearing components in the receptacle containing the hard particles and usually a fluid carrier. The particles are typically alumina or other ceramics and can vary in size from a few microns to over a millimetre. The hardness of the particles is normally equal to or greater than that of the bearing component to be treated and the fluid is usually water. Corrosion inhibitors may be added to the fluid.

The or each bearing component and/or the hard particles in the fluid are agitated to give relative movement between the bearing components and the particles. The resulting

impact or action of the hard particles on the surface of the bearing component primarily modifies the topography of the surface, giving an improved surface finish, and preferably induces beneficial residual compressive stress in the surface. The modified surface topography has better tribological properties and the residual stress offsets the stresses experienced by the bearing component during use. Preferably, the surface finish of the component is improved to below  $0.10\text{ }\mu\text{m}$ , preferably to around  $0.07\text{ }\mu\text{m}$ . A pre-treatment surface finish of around  $0.13\text{ }\mu\text{m}$  could be typical.

The process of hard particle abrasion when applied to bearing components alleviates surface defects that can be introduced into the component surface, for instance the raceway surface, by conventional grinding and honing. In addition, consistently good surface finishes can be achieved, preferably without the need for expensive finish grinding and honing.

#### DETAILED DESCRIPTION OF PREFERRED IMPLEMENTATIONS

In practice several components are treated at once.

In an example of performing the method of the present invention, bearing components are treated for around 30 minutes. The components are supported in a bath containing water with a corrosion inhibitor and alumina particles of size 10 microns. Relative

movement between the bearing components and alumina particles is provided by rotating the components in one direction while the bath is rotated in the opposite direction.

A range of alumina particle sizes may be used and an alternative example uses a typical particle size of 1 mm. Generally, the components are treated for between 10 minutes to 1 hour although 30 minutes is typical. Generally, the speed of rotation of the bath is between 30 rpm and 90 rpm, typically 60 rpm and the speed of rotation of the component is between 5 rpm and 15 rpm, typically 10 rpm.

An assessment before and after such abrasion of bearing inner rings made in M50 NiL material shows that the surface finish (Ra) is improved from around 0.1282 to 0.0715  $\mu\text{m}$ . The roundness of the rings was not significantly affected and the material removed per surface was about 4  $\mu\text{m}$ . The raceway of the ring required little or no further grinding or honing.

Polymet testing of ceramically abraded bearing components made in M50 NiL material gave an improvement in fatigue life of over 12 times that of untreated components.

Measurement of the residual compressive stress in the surface of M50 NiL bearing components shows that ceramic abrasion increases the compressive stress in the surface of the components by several hundred MPa. The increase in residual compressive stress

09762652-042701

produced in the surface of a component treated in accordance with the method of the invention is between 200 MPa and 500 MPa, typically 400 MPa.

The improved surface topography and the residual compressive stress induced in the surface of the bearing components improve the fatigue resistance of the bearing components and consequently the bearing itself. In particular rolling contact fatigue performance is improved.

Rolling element bearings comprising components that have been treated in accordance with the invention may be used where an improvement in bearing performance is required. Particular examples are gas turbine engine main shaft bearings for use in aerospace or other applications.

10976666.04201  
T02240" 25929460



*Claims*

1. Use of non-corrosive hard particle abrasion to treat a rolling element bearing component, the hard particle abrasion including the steps of:

immersing the bearing component in a receptacle containing hard particles; and

agitating the bearing component and/or hard particles to produce relative movement therebetween and to improve the surface topography of the component.

2. Use according to claim 1, wherein the hard particle abrasion is performed for between 10 minutes and 1 hour.

3. Use according to claim 1 or 2, wherein the relative movement is produced by rotating the component in one direction while the receptacle is rotated in the opposite direction.

4. Use according to any one of claims 1 to 3, wherein the hard particles comprise alumina.

5. A rolling element bearing component treated in accordance with any one of the preceding claims.

09/762652-0401

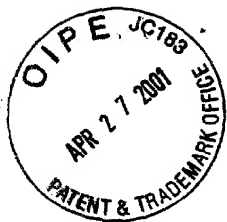
6. A rolling element bearing component according to claim 5 wherein the surface finish of the component is improved from around 0.13  $\mu\text{m}$  to around 0.07  $\mu\text{m}$ .
7. A rolling element bearing component according to claim 5 or claim 6, wherein the compressive stress in the surface of the component is increased by between 200 MPa and 500 MPa.
8. A rolling element bearing component according to any one of claims 5 to 7, wherein the rolling contact fatigue life of the component is significantly enhanced.
9. A rolling element bearing component according to any of claims 5 to 8, wherein a surface finish on the component is produced which requires no further machining.
10. A rolling element bearing comprising one or more components according to any one of claims 5 to 9.

T06240-2529260

## ***IMPROVEMENTS IN ROLLING ELEMENTS BEARINGS***

### ***Abstract***

A method of treatment of a rolling element bearing component by hard particle abrasion to improve the surface topography of the component. The hard particle abrasion includes the steps of immersing the bearing component in a receptacle containing hard particles, preferably alumina, and agitating the component and/or hard particles to produce relative movement. Preferably the method is performed for between 10 minutes and 1 hour. The relative movement may be produced by rotating the component in one direction while the receptacle is rotated in the opposite direction. The surface finish of the component is preferably improved from around  $0.13\text{ }\mu\text{m}$  to around  $0.07\text{ }\mu\text{m}$ . Compressive stress in the surface of the component may also be improved, typically by between 200 MPa and 500 MPa. Rolling contact fatigue life of the component is also improved.



## DECLARATION AND POWER OF ATTORNEY

We, the below named inventors, hereby declare that:

Our residences, post office addresses, and citizenships are as stated below next to our respective names.

We believe we are the original, first, and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled, the specification of which is attached hereto and which claims priority from PCT Application No. PCT/GB00/02266 filed on June 12, 2000.

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

We acknowledge the duty to disclose information which is material to patentability in accordance with Title 37, Code of Federal Regulations, Section 1.56.

We hereby declare that all statements are made hereby of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And we hereby appoint:

Maurice E. Gauthier	-	Reg. No. <u>20,798</u>
Richard L. Stevens	-	Reg. No. <u>24,445</u>
Matthew E. Connors	-	Reg. No. <u>33,298</u>
William E. Hilton	-	Reg. No. <u>35,192</u>
Patrick J. O'Shea	-	Reg. No. <u>35,305</u>
Arlene J. Powers	-	Reg. No. <u>35,985</u>
Richard L. Stevens, Jr.	-	Reg. No. <u>44,357</u>

7

all of the firm of Samuels, Gauthier & Stevens, our attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

We request that all correspondence be directed to:

Samuels, Gauthier & Stevens, LLP  
225 Franklin Street, Suite 3300  
Boston, MA 02110

Attn: Arlene J. Powers

1-00  
Andrew Dodd  
(Full Name of Inventor)

5.4.01  
(Date)

Great Britain  
(Citizenship)

2-00  
Mark Philip Dicks  
(Full Name of Inventor)

5.4.01  
(Date)

Great Britain  
(Citizenship)

3-00  
Mark Stephen Taylor  
(Full Name of Inventor)

5.4.01  
(Date)

Great Britain  
(Citizenship)

[Signature]  
(Inventor's Signature)

6 Halls Brook, East Leake  
Loughborough, Leicestershire LE12 6HE  
GREAT BRITAIN  
(Residence)

Same as above  
(Post Office Address)

[Signature]  
(Inventor's Signature)

20 Hine Avenue, Newark  
Nottinghamshire NG24 2LH  
GREAT BRITAIN  
(Residence)

Same as above  
(Post Office Address)

[Signature]  
(Inventor's Signature)

10 Bateman Road, East Leake  
Loughborough, Leicestershire LE12 6LN  
GREAT BRITAIN  
(Residence)

Same as above  
(Post Office Address)

09762652 042701